the differences above noted[1] are of specific value."[2] I may add that I have recently seen the specimens of Tudor limestone exhibited in the Peter Redpath Museum, and my estimate of their value coincides exactly with that of Sir J. W. Dawson in 1888. As Sir J. W. Dawson most kindly promises his assistance to other workers, perhaps he would submit to some of them any specimens from Tudor which he regards as more conclusive than his original type.

It would seem rather unnecessary for anyone to trouble to infer from my paper that Sir J. W. Dawson has "regarded the Madoc and Tudor specimens as 'Lower Laurentian,'" when that is so directly stated by Sir J. W. Dawson in his description of his figure; viz. "Specimen of *Eozoon canadense* embedded in a dark-coloured homogeneous limestone occurring in the Lower Laurentian series at Tudor, Canada West" (*Quart. Journ. Geol. Soc.*, vol. xxiii. p. 265). J. W. Gregory.

British Museum (Natural History), S.W.

The Theory of Solutions.

In his last letter (Nature, March 3, p. 415) Prof. Ostwald repeats his opinion that a theory is "a complex of laws, grouped around and derived from a main law," and infers from my letter that what I term a *theory* he would term an *hypothesis*.

If this were the whole point at issue, I could meet it in no better way perhaps than by referring Prof. Ostwald to his own works. For example, in his "Outlines of General Chemistry," are to be found not only numerous instances of the use of the word theory in its ordinary and accepted sense (*e.g.*, p. 58) but also cases in which it is employed as synonymous with hypothesis (*e.g.*, p. 187).

With regard to the definition of solutions as mixtures, Prof. Ostwald maintains that even if hydrates are formed in a solution, the solution is finally a mixture of the hydrates and the remaining solvent. The real question involved is unaffected by this explanation. There is no doubt whatever that to the majority of readers the definition, without any qualifying clause, that solutions are mixtures leads to one conclusion and no other—namely, that between solvent and dissolved substance there is no interaction of a chemical nature. Prof. Ostwald has in his letters stated that in some cases he considers such interactions occur; he has also stated that between chemical and physical processes he knows of no distinction. The definition is at variance with both these views, and it seems but fair to conclude that such discordant statements tend in no way to obviate that misconception which Prof. Ostwald so often deplores.

In defence of the application of van der Waals's equation to solutions, a process questioned by me in my letter, Prof. Ostwald states that van der Waals himself has taken up this very question. The method by which van der Waals approaches the subject, curiously enough, furnished the main grounds for my objections. The most superficial comparison of the complex formula which van der Waals deduces for a mixture of two substances, with such an application of his simple gas equation to a solution as that given in Prof. Ostwald's book, is ample justification for my strictures. But apart even from such evidence as to the inadequacy of the application, the form which it is finally made to assume is in itself a proof of its incompleteness. By judicious simplification the application is made to take the shape of a linear equation in which "pressure forces due to the interactions of molecules are absent." That is to say, the cohesion of solvent and dissolved substance, and the mutual reactions of both, are alike ignored. Further comment on such a method of accounting for the phenomena of solutions appears to me to be superfluous. J. W. Rodger.

London, March 7.

The Limpet's Strength.

The limpet experiments of your esteemed correspondent, Mr. Percy Aubin, as reported in Nature of March 17 (p. 464) would have been still more interesting and instructive had he weighed the animals deprived of their shells.

On April 10, 1890, I published my experiments showing that the shell-less limpet pulls 1984 times in the air its own weight, and about double when immersed in water.

Fasting fleas on an average pull 1493 times their own dead weight.

Other experimenters give the pulling power of the shell-deprived *Venus verrucosa* of the Mediterranean, a cockle-like creature, at 2071 times the weight of its own body.

The force required to open an oyster appears to be 1319·5 times the weight of the shell-less oyster.

J. Lawrence-Hamilton, M.R.C.S.

30 Sussex Square, Brighton, March 19.

Technical Education for Novelists.

Amidst the many schemes for technical education, could you not put in a plea for the "author of the popular novel"? Perhaps the need will best appear from these illustrations taken from the first 100 pages of a recently published and loudly heralded work.

(1) Scene—Kinder Scout, Derbyshire. Date—"after the snows and rains of early April," 1864. Time—*after* 8 *p.m.* "It was a clear, frosty night, *promising* a *full* moon."

(2) Same place, *Easter Eve*, 1864. "The wooded sides of the great moor were fading into dimness, and to the east a *young* moon was *rising*." W.

March 12.

THE ORIGIN OF THE YEAR.

I.

It would seem that in the dawn of civilization it was not at all a matter of course that the sun should be taken as the measurer of time, as it is now with us; and in this connection it is worth while to note how very various the treatment of this subject was among the early peoples. Thus, for instance, it was different in Egypt from what it was in Chaldæa and Babylonia, and later among the Jews. In the Egyptian inscriptions we find references to the moon, but they prove that she occupied quite a subordinate position to the sun; while in Chaldæa it would seem that the moon was the chief thing worshipped, and it was thus naturally the chief means used for measuring time, and, so far as months were concerned, this, of course, was quite right. In Chaldæa, too, where much desert travel had to be undertaken at night, the movement of the moon would be naturally watched with great care.

An interesting point connected with this is that, among these ancient peoples, the celestial bodies which gave them the unit period of time by which they reckoned were practically looked upon in the same category. Thus, for instance, in Egypt the sun being used, the unit of time was a year; but in Chaldæa the unit of time was a month, for the reason that the standard of time was the moon. Hence, when periods of time were in question it was quite easy for one nation to conceive that the period of time used in another was a year when really it was a month, and *vice versâ*. It has been suggested that the years of Methuselah and other persons who are stated to have lived a considerable number of years were not solar years but lunar years—that is, properly, lunar months. This is reasonable, since if we divide the numbers by 12 we find that they come out very much the same length as lives are in the present day.

There seems little doubt that the country in which the sun was first definitely accepted as the most accurate measurer of time was Egypt.

"The Egyptians," says Ranke in the first chapter of his "Universal History," which is devoted to Egypt, "have determined the motion of the sun as seen on earth, and according to this the year was divided, in comparison with Babylon in a scientific and practically useful way, so that Julius Cæsar adopted the calendar from the Egyptians and introduced it into the Roman Empire; the other nations followed suit, and since then it has been in general use for seventeen centuries. The calendar may be considered the noblest relic of the most ancient times which has influenced the world."

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[1] *i.e.* between *the* specimen from Tudor and those from other localities.

[2] "Specimens of *Eozoon canadense*," Mem. Peter Redpath Mus., 1888, p. 43.

A study of the Egyptian monuments has shown most conclusively that towards the end of the ancient empire the Egyptians possessed a year as accurate for calendar purposes as our own, and that they had been led up to the knowledge of its true length by successive steps.

As we shall show further on, this earliest of all years that we know of in history began at the summer solstice. Since one of the oldest temples at Thebes is oriented to sunset at the summer solstice, we should be not at all surprised if investigation shows that when that temple was built, more than 3000 years B.C., the Egyptian year really began in what we should call our summer. We have ample evidence of this. And I think there is little doubt also that when Stonehenge was built it certainly was built by people who began their year with the summer solstice, which is the time of the year in which in many countries it is the habit still to light fires upon hills and so on. If we look up the records of the peoples that lived, say, during the 1000 years preceding the birth of Christ, we find that the different races began their year at different times, and even that the same race at different times began their year differently; the choice lay among the equinoxes and the solstices.

Wherever the ancient Egyptians came from, whether from a region where the moon was the time-measurer or not, so soon as they settled in the valley where the Nile then as now like a pendulum slowly beat the years by its annual overflows at the summer solstice, the solar basis of their calendar was settled.

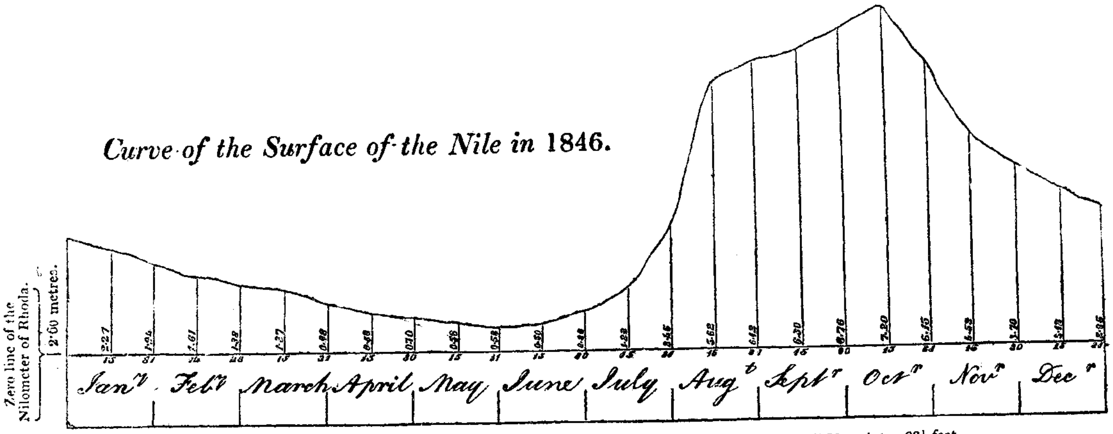

FIG. 1.—The annual rise and fall of the Nile (from Horner).

We can well understand, therefore, since the whole life of the country depends upon the river, and all the energies of the inhabitants are connected with the work to be done during its rise and fall, that the moment of the commencement of the inundation, about the time of the summer solstice, should be chosen as the beginning of the year. Hence the perpetual reference to Solstice and Nile flood in the Egyptian annals.

It might be imagined at first sight that, as the year was thus determined, so to speak, by natural local causes, the divisions or seasons would be the same as those which Nature has given *us*. This is not so. Egypt is too near the tropics and the local conditions are too different from our own, to permit of the application of our seasonal divisions of the year.

As Egypt, in the description quoted by Krall, "first appears like a dusty plain, then as a fresh-water sea, and finally as a bed of flowers," so the year is divided into three seasons instead of four.

Beginning with the inundation (summer solstice) we have—

(1) The season or *tetramene* of the inundation,
(2) ,, ,, ,, sowing,
(3) ,, ,, ,, harvest.

From the earliest times the year was divided into twelve months, as follows:—

Inundation ...	Thoth ...	End of June (Gregorian).
	Phaophi	,, July.
	Athyr	,, August.
	Choiak	,, September.
Seed time ...	Tybi	,, October.
	Menchir	,, November.
	Phamenoth ...	,, December.
	Pharmouthi ...	,, January.
Harvest ...	Pachons	,, February.
	Payni	,, March.
	Epiphi	,, April.
	Mesori	,, May.

Now whether the Egyptians brought their year with them or invented it in the Nile valley, there is a belief that it at first consisted of 360 days only, that is 5¼ days too little. It is more likely that they brought the lunar month with them, taking it roughly as 30 days (30 × 12 = 360), than that they began with such an erroneous notion of the true length of the solar year, seeing that in Egypt, above all countries in the world, owing to the regularity of the inundation, the true length could have been so easily determined, so soon as that regularity was recognized. We must not in these questions forget to put ourselves in the place of these pioneers of astronomy and civilization; if we do this, we shall soon see how many difficulties were involved in determining the true length of such a cycle as a year, when not only modern appliances, but all just ideas too, were of necessity lacking.

Still it is right that I should state that all authorities are not agreed as to the use of this year of 360 days. Ideler[1] considers it very doubtful. Krall,[2] however, urges that a certain inscription (the trilingual inscription of Tanis) expressly refers to it.

He adds to this some evidence, which he considers confirmatory, from religious usages. Thus at Philoe, in the temple of Osiris, there were 360 bowls for sacrifice, which were filled daily with milk by a specified rotation of priests. At Acanthus there was a perforated cask into which one of the 360 priests poured water from the Nile daily. Krall adds :—[1]

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[1] "Chronologie," i. p. 70.

[2] "Studien zur Geschichte des alten Aegypten," i. p. 16.

"It is probable that the year of 360 days dates from the time before the immigration into the Nile valley, when the Egyptians were unguided by the regular recurrence of the Nile flood. In any case, this must soon have convinced the priests that the 360-days year did not agree with the facts. But it is well known to everybody familiar with these things how long a period may be required before such determinations are practically realized, especially with a people so conservative of ancient usages as the Egyptians."

Supposing the use of this 360-day year to have been universal, it is perfectly certain that the Egyptians, now in this part of the Nile valley, now in that, must have got their calendar into the most hopeless confusion, compared with which "the year of confusion" was mere child's-play, and that the exact determination of the times of sowing, reaping, &c., by means of such a calendar would have been next to impossible.

As each year dropped $5\frac{1}{4}$ days, it is evident that in about seventy years $\left(\frac{365\cdot25}{5\cdot25}\right)$ a cycle was accomplished, in which new year's day swept through all the months. The same month (so far as its name was concerned) was now in the inundation time, now in the sowing time, and so on. Of fixed agricultural work for such months as these there could be none.

It must have been, then, that there were local attempts to retain the coincidences between the beginning of the year and the Nile flood and solstice ; intercalation of days or even of months being introduced, now in one place, now in another ; and these attempts, of course, would make confusion worse confounded, as the months might vary with the district, and not with the time of the year.

That this is what really happened is, no doubt, the origin of the stringent oath required of the Pharaohs in after times, to which I shall subsequently refer.

This year of 360 days had naturally to give way, and it ultimately did so in favour of one of 365. The precise date of the change is not known, but it is referred to in inscriptions of the time of Amenemha I. (*circ.* 2400 B.C.). This, of course, does not exclude the possibility, indeed even the probability, that it was introduced much earlier. The five days were added as epacts or epagomena ; the original months were not altered, but a "little month" of five days was interpolated at the end of the year between Mesori of one year and Thoth of the next.

When the year of 365 days was established, it was evidently imagined that finality had been reached ; and mindful of the confusion which, as we have shown, must have resulted from the attempt to keep up a year of 360 days by intercalations, each Egyptian king on his accession to the throne bound himself by oath before the priest of Isis, in the temple of Ptah at Memphis, not to intercalate either days or months, but to retain the year of 365 days as established by the Antiqui.[2] The text of the Latin translation preserved by Nigidius Figulus, cannot be accurately restored. Only thus much can be seen with certainty.

To retain this year of 365 days then became the first law for the king, and indeed the Pharaohs thenceforth throughout the whole course of Egyptian history adhered to this year, in spite of their being subsequently convinced, as we shall see, of its inadequacy for a long period. It was a Macedonian king who later made an attempt to replace it by a better one

The years of 360 and 365 days to which we have so far referred are termed in the inscriptions the "little" and "great" years respectively.

How, then, was this 365-day year, which had been introduced with such pomp and circumstance, regulated? This brings us to a new point.

The Heliacal Rising of Sirius.

I have insisted upon the perfect regularity of the rise of the Nile affording the ancient Egyptians, so soon as this regularity had been established, a nearly perfect way of determining the length of the year.

It is also clear that so soon as the greatest northing and southing of the sun rising or setting at the solstices had been recognized, and that the intervals between them in days had been counted, a still more accurate way would be open to them, especially if, as I believe, the observations of the solsticial risings or settings were made in temples (or observatories) accurately oriented to the proper amplitude.

In this way, then, the great natural festival of the year would be the nearly coincident commencement of the inundation and the summer solstice.

As I have said, the solstice might have, one may say *must* have, occurred with greater regularity than the rise of the river, so that as accuracy of definition became more necessary the solstice would be preferred. The solstice was common to all Egypt, the commencement of the inundation was later as the place of observation was nearer the mouth of the river.

Now it seems as if among all ancient peoples each sunrise, each return of the sun—or of the sun-god—was hailed, and most naturally, as a resurrection from the sleep—the death—of night : with the returning sun, man found himself again in full possession of his powers of living, of doing, of enjoying. The sun-god had conquered death, man was again alive. Light and warmth returned with the dawn in those favoured eastern climes where man then was, and the dawn itself was a sight, a sensation, in which everything conspired to suggest awe and gratitude, and to thrill the emotions of even uncivilized man.

What wonder, then, that sunrise was the chief time of prayer and thankfulness? But prayer to the sun-god meant, then, sacrifice, and here a practical detail comes in, apparently a note of discord, but really the true germ of our present knowledge of the starry heavens which surround us.

To make the sacrifice at the instant of sunrise, preparations had to be made, beasts had to be slaughtered, and a ritual had to be followed ; this required time, and a certain definite quantity of it ; to measure this, the only means available then was to watch the rising of a star, the first glimmer of which past experience had shown preceded sunrise by just that amount of time which the ritual demanded for the various functions connected with the sunrise sacrifice.

This, perhaps, went on every morning, but beyond all question the most solemn ceremonial of this nature in the whole year was that which took place on New Year's morning, or the great festival of the Nile-rising and summer solstice, the 1st of Thoth.

How long these morning and special yearly ceremonials went on before the dawn of history we, of course, have no knowledge. Nor are the stars thus used certainly known to us ; of course any star would do which rose at the appropriate time before the sun itself, whether the star was located either in the northern or southern heavens. But in historic times there is no doubt whatever about the star so used. The warning-star watched by the Egyptians at Thebes, certainly 3000 B.C., was Sirius, the brightest of them all, and there is much evidence that Sirius was not the star first used.

"Besides the solstice and the beginning of the Nile flood, there was an event in the sky which was too striking not to excite the general attention of the Egyptian priesthood. We also know from the newly-discovered inscriptions from the ancient empire that the risings of Orion and Sirius were already attentively followed and mythologically utilized at the time of the building of the pyramids."[1]

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[1] *Loc. cit.*, p. 20.

[2] Mommsen, "Chronologie," p. 258.

J. Norman Lockyer.

(*To be continued.*)

THE WINTER STORMS OF NORTHERN INDIA.

THE physical constitution and history of the storms of India and Indian Seas is a subject which, almost from his first association with the Indian Meteorological Department, Mr. Eliot has made peculiarly his own. Besides nine elaborate, and, as far as possible, exhaustive, memoirs and reports on the history of particular storms, two on the tracks and periodicity of the cyclones of the Bay of Bengal during the ten years 1877–1886, and an admirable hand-book, in which he has summarized, for the guidance of seamen, the characteristic features and behaviour of these storms, his annual reports on the meteorology of India have always been replete with the results of his studies of the storms of the current year; and to him is mainly due that development which has been effected in the system of storm warnings for the coasts of India in recent years, and has rendered it one of the most efficient and comprehensive organizations for that purpose now in operation in any part of the world.

Like most other features of the climate, the storms of India differ very greatly in their leading characteristics at different seasons of the year. We have, in the first place, the well-known cyclones and cyclonic storms of the Bay of Bengal and the Arabian Sea, which are most frequent when the summer monsoon is at its height, and most severe at its commencement and termination. These are generated over some part of the tropical sea north of latitude 6°, and travel, as is now well known, on tracks between west and north—most frequently north-west or west-north-west; sometimes, however, in the spring and later months of the year, recurving to north-north-east or even north-east, as they approach the tropic. In virtue of their severity and destructiveness, these storms have attracted far more attention than any others, and not only Piddington's, but also the writings of most of his successors, have been almost exclusively devoted to them.

Of a very different type are the storms that bring the rainfall of the cold season and the earlier spring months to Northern India. It would be incorrect to speak of these as the storms of the winter monsoon (unless the term be understood, in its strictly etymological sense, as merely the name for a season of the year), for during their passage the northerly winds are suspended over a great part of India, and, with the rarest exceptions, they never penetrate far into the tropics. These storms, if they travel, always move from west to east. They have the usual cyclonic constitution, but the winds have but little force; and it was not until the preparation of daily weather charts for the first time showed their true nature, that this fact was even suspected.

Many of the features of these cold-weather storms are very striking and characteristic, and, as has been remarked by Mr. Eliot in his reports for 1888 and 1889, the temperature of Northern India in the cold season is chiefly determined by their number and character. Each of them is preceded by a wave of high temperature, and followed by a cold wave; except, indeed—and the exception is instructive—when the course of the storm is so far south of the Himalayas that little or no snow falls on the mountains (see "Climates and Weather of India," p. 206). In these cases, which are, however, exceptional, the cold wave is sometimes evanescent. On the other hand, as Mr. Eliot remarks, "the intensity and period [of the cold wave] largely depend on the amount of rainfall in Northern India and of the snowfall on the Himalayan mountain regions, and the height to which the snow-line has descended." As a rule, therefore, the cold wave follows the storm. Mr. Eliot gives, in his report, a table of the changes of temperature from day to day from January 20, to February 7, 1889, which includes two very characteristic illustrations of this phenomenon, and which therefore we extract. The figures show the variations of the observed mean temperature of each day from the average of many years for the same day. The crest of each warm wave is emphasized by strong type and the trough of each cold wave by italics.

The history of these two storms is as follows, and it exhibits one or two remarkable and suggestive features, which will presently be noticed more particularly. The first disturbance originated (or made its first appearance in India) on January 22. There were two separate centres and areas of disturbance, one of which covered the Punjab Himalaya and adjacent plains from Sialkote to Roorkee. This filled up [apparently] on the 23rd, after giving moderate snow on the hills and light showers on the adjacent plains. The other originated in Rajputana, and advanced, on the 23rd and 24th, in an easterly direction, across Northern India into Burma. It gave moderate general rain to the North-West Provinces and Central India, and light showers to Behar, Bengal, and Assam. This first storm was therefore of very moderate intensity. The snowfall and rainfall were but slight, and in the Punjab, Bengal, and Burma insufficient to bring down the temperature below the normal average.

The second disturbance was one of greater intensity, but like its predecessor had a double centre. One part consisted of a shallow depression, which passed into Sind from Baluchistan on the 28th, advanced through Central India, Behar, and Bengal, on the three following days, and into Burma on February 1, where it slowly filled up during the next three days. The other part was a deep depression, which formed in the Northern Punjab on the evening of the 28th, and during the next thirty-six hours marched slowly to the south-east along the southern face of the Punjab Himalayas. It filled up very rapidly on the evening of the 30th, and morning of the 31st of January, in the South-Eastern Punjab. The double disturbance gave a very heavy fall of snow over the whole of the Western Himalaya, bringing the snow-line down to 3500 or 4000 feet, and also general rain to nearly the whole of Northern and Central India, which was greatest in amount in the Punjab, the North-West Provinces, and Behar. As is shown by the table (see next page), the fall of temperature after this storm was proportionately great, amounting to 9½° in the Punjab, and to 14° or 15° on the mean of the day in Guzerat, Central India, and the Central Provinces. It continued three or four days after the weather had cleared up, so that the trough of the cold wave followed the crest of the warm wave after an interval of five or six days, and each occupied three or four days in passing from the Punjab to Burma. Mr. Eliot gives eight charts in illustration of these waves, of which we reproduce those for January 30 and 31 and February 1. They are projected for the observed temperatures at 8 a.m. of those days, and show, not the temperatures themselves, but the amounts by which these deviate in excess or defect from the averages of many years at the same hour. The isabnormals of deficient temperature are represented by broken, those of excessive temperature by continuous lines.

Mr. Eliot remarks that in the warm waves the greatest excess is generally exhibited by the night temperatures; and in a table which he gives of the deviations of the daily maxima and minima from their respective normal

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[1] Krall, *op. cit.*, p. 45. See also Brugsch, "Aeg. Zeit.," 1881, p. 1, *seqq.*